

# Emission Calculations

The EPA Diesel Emission Quantifier program was used to quantify criteria emissions from the vehicles, and TRUs. ZANZEFF information was used to quantify GHG emissions from each source. The link below is the ZANZEFF reference source.

[https://ww2.arb.ca.gov/sites/default/files/classic/msprog/mailouts/msc1810/zanzeff\\_appendix\\_d.pdf](https://ww2.arb.ca.gov/sites/default/files/classic/msprog/mailouts/msc1810/zanzeff_appendix_d.pdf)

## EPA Diesel Emission Quantifier (DEQ) Results

**Criteria Emission were quantified using the DEQ for replacing six (6) diesel powered Class 6 trucks, five (5) diesel Class 8 tractors, and sixteen diesel powered TRUs with comparably powered and operated zero emissions battery electric vehicles, and eTransport Refrigeration Units (eTRUs).**

Assumptions applied in the EPA DEQ program:

- Baseline Vehicles/Fuels: Class 6 diesel; Class 8 diesel; TRU diesel
- Model Year: 2014 for Vehicles and TRUs (Tier 4 Final)
- Replacement Vehicles: all battery electric
- Replacement TRUs: all battery electric

Operations:

- Vehicles: Six (6) Short-haul delivery Class 6; five (5) Short-haul Class 8 Combination
- Miles/Year/Vehicle: Class 6: 30,000 miles; Class 8 50,000 miles (assumed annual project miles)
- Fuel Economy: Class 6: 10 mile per gallon fuel efficiency (default) or 3,000 gallons diesel consumed per vehicle per year; Class 8: 50,000 miles/year/vehicle and 5.89 miles per gallon fuel efficiency (default) or 8,500 gallons diesel consumed per vehicle per year
- TRUs: Sixteen diesel powered Tier 4 (Final) Transport Refrigeration Units (TRUs), default values applied to determine annual fuel consumption.

# Emission Results

Here are the combined results for all groups and upgrades entered for your project.<sup>1</sup>

<b><u>Annual Results (short tons)<sup>2</sup></u></b>	<b>NO<sub>x</sub></b>	<b>PM2.5</b>	<b>HC</b>	<b>CO</b>	<b>CO<sub>2</sub></b>	<b>Fuel<sup>3</sup></b>
Baseline for Upgraded Vehicles/Engines	2.139	0.029	0.110	0.317	949.0	84,356
Amount Reduced After Upgrades	2.139	0.029	0.110	0.317	949.0	84,356
Percent Reduced After Upgrades	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

<b><u>Lifetime Results (short tons)<sup>2</sup></u></b>						
Baseline for Upgraded Vehicles/Engines	21.389	0.288	1.100	3.166	9,490.1	843,560
Amount Reduced After Upgrades	21.389	0.288	1.100	3.166	9,490.1	843,560
Percent Reduced After Upgrades	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

<b><u>Lifetime Cost Effectiveness (\$/short ton reduced)</u></b>						
<b>Capital</b> Cost Effectiveness <sup>4</sup> (unit & labor costs only)	\$112,208	\$8,343,243	\$2,182,401	\$758,002	\$253	
<b>Total</b> Cost Effectiveness <sup>4</sup> (includes all project costs)	\$537,663	\$39,978,038	\$10,457,339	\$3,632,093	\$1,212	

<sup>1</sup> Emissions from the electrical grid are not included in the results.

<sup>2</sup> 1 short ton = 2000 lbs.

<sup>3</sup> In gallons; fuels other than ULSD have been converted to ULSD-equivalent gallons.

<sup>4</sup> Cost effectiveness estimates include only the costs which you have entered.

## Remaining Life

Vehicle or Engine Group	Remaining Life
<b>TRU:</b> Freight   Transport Refrigeration Unit Engine Replacement - All-Electric	10 years
<b>Class 6 All Electric Food:</b> Freight   Short Haul - Single Unit   Class 6-7 (Delivery) Vehicle Replacement - All-Electric, Vehicle Replacement - All-Electric	10 years
<b>Class 8 All Electric Food Transport:</b> Freight   Short Haul - Combination   Class 8 (Delivery) Vehicle Replacement - All-Electric	10 years

## Health Benefits Results

The table below shows the estimated PM2.5 reductions and health benefits by county and as a total for your project. Results are based on the inputs you have entered.

Annual Benefits represent the dollar value of health benefits resulting from reduced exposure to PM2.5. These benefits include the reduction of premature mortality, chronic bronchitis, asthma attacks, non-fatal heart attacks, and other health problems. The dollar values are based on studies used by EPA when estimating the health benefits of environmental rules.

Annualized Costs are based on the unit and labor costs you have entered. They have been annualized over the remaining life of the upgraded project.

Health Benefits Results			
County and State	Annual Diesel PM2.5 Reduction (short tons)	Annual Benefits	Annualized Unit & Labor Costs
Riverside, California	0.029	\$43,000	-
<b>Total</b>	0.029	\$43,000	\$280,000

# Greenhouse Gas Calculations and Results

Listed below are the assumptions, emission factors, and conversion factors to quantify greenhouse gas emissions from the replacement of the following diesel powered equipment: six Class 6 short haul delivery trucks, five Class 8 short haul combination tractors, and sixteen Tier 4 diesel transport refrigeration units (TRUs). All diesel listed is replaced with comparably powered battery electric equipment. Basic information for calculating GHG emissions was derived from:

APPENDIX D - METHODOLOGY FOR DETERMINING EMISSION REDUCTIONS AND COST-EFFECTIVENESS Zero- and Near Zero-Emission Freight Facilities Project (ZANZEFF), Mobile Source Control Division California Air Resources Board March 21, 2018, California Air Resources Board.

	Baseline , Diesel Equipment			
	Six Class 6	Five Class 8	Sixteen TRU	Source
Carbon Intensity, ULSD, g-CO <sub>2</sub> e/MJ, ZANZEFF Page D-57	102.01	102.01	102.01	ZANZEFF
Energy Density Diesel, MJ/gal diesel	134.47	134.47	134.47	ZANZEFF
Fuel Consumed, gal diesel/year	18,000	42,500	23,856	DEQ
Fuel economy, mpDGE; TRU gal/hr	10	5	1.112	DEQ
Annual hours, TRU			1341	DEQ
g/metric ton (g/MT)	1,000,000	1,000,000	1,000,000	
<b>MT CO<sub>2</sub>e/year</b>	<b>246.91</b>	<b>582.98</b>	<b>327.24</b>	<b>1,157.14</b>
<b>Quantifying MT of CO<sub>2</sub> equivalents from Diesel Operations, based on gal/year</b>				
= [CI, gCO <sub>2</sub> e/MJ x Energy Density diesel (MJ/gal) x Annual Fuel consumed (gal/year)] / 1,000,000 g/MT				

	All Electric Equipment			
	Six Class 6	Five Class 8	Sixteen TRU	Source
Carbon Intensity, CA Grid, g-CO <sub>2</sub> e/MJ, ZANZEFF Page D-57	105.16	105.16	105.16	ZANZEFF
Energy Efficiency Ratio, EER for Electricity relative to Diesel	5.5	5.5	5.5	ZANZEFF
Energy Density Electricity, MJ/kWh	3.6	3.6	3.6	ZANZEFF
Energy Density Diesel, MJ/gal diesel			134.47	ZANZEFF
miles/year	30,000	50,000		Project
Fuel economy, kWh/mi	1.4	2.1		Daimler Project
kWh/year	252,000	525,000	162,016	ZANZEFF
g/metric ton (g/MT)	1,000,000	1,000,000	1,000,000	

<b>MT CO2e/year</b>	<b>95.40</b>	<b>198.75</b>	<b>61.34</b>	<b>355.5</b>
<b>Quantifying MT of CO2 equivalents from Electric Operations, based on kWh/Year</b>				
= [CI, gCO2e/MJ x Energy Density CA grid (MJ/kWh) x Annual Electricity consumed (kWh/year)] / 1,000,000 g/MT				
<b>Energy Conversion from diesel gallons to kWh to determine total kWh consumed by eTRUs</b>				
= [Annual Diesel Fuel Consumer (gal/yr) x ((Energy Density Diesel, MJ/gal) / Energy Density Electricity, MJ/kWh)) / EER]				

<b>REDUCTIONS</b>	<b>Six Class 6</b>	<b>Five Class 8</b>	<b>Sixteen TRU</b>	<b>Project Totals</b>
ANNUAL MT	152	384	266	801.65
PROJECT LIFE, 10 year	1,515	3,842	2,659	8,016.46
Annual from All Vehicles	536		266	801.65
Project from All Vehicles	5,357		2,659	8,016.46